evidence. For instance, with reference to the jaw under discussion Pengelly adds the remark, "Nothing of the kind was subsequently met with in or under the Granular Stalagmite" (*loc. cit.*, p. 221).

A. R. HUNT.

Torquay, September 16.

MR. HUNT is under a misapprehension regarding my criticism of Prof. Boyd Dawkins's communication at the Anthropological Section of the British Association at Dundee. In making the important announcement that the remains of Neanderthal man had been discovered in England, Prof. Dawkins exhibited merely a rough sketch of a fragment of a human jaw—not the actual specimen itself. So far as the sketch went it showed none of the usual Neanderthal characters. Further, he was unable to say from which stratum of the floor of Kent's Cavern the original specimen had been derived. My criticism of "ridiculous" and "unscientific" applies merely to the fact that the meeting was asked to accept the discovery of Neanderthal man in England on a specimen which was absent and of uncertain origin. From Mr. Hunt's communication it is clear that the exact origin of the specimen could have been ascertained. I firmly believe that the remains of Neanderthal man will be discovered in England—it may be that Dr. Duckworth is right regarding the specimen from Kent's Cavern—but the discovery cannot be accepted unless the evidence is produced.

A. KEITH.

EXPERIMENTAL RESEARCHES ON VARIATIONS IN THE COLOURING OF LEPIDOPTERA.[1]

THIS is a very comprehensive treatise by Dr. Pictet, a former treatise by whom on a cognate subject was reviewed in NATURE in 1905 (vol. lxxii., p. 632). It begins with a *résumé* of previous researches by various authors, classified under several heads, and proceeds to describe the author's own researches and the conclusions he draws from them. Many of the details are highly interesting, and his observations upon them are of much weight.

Lepidoptera, Dr. Pictet tells us, with few exceptions, vary in only two directions, melanism and albinism; the law laid down by Oberthur may be thus summed up: Any part of the wing of a butterfly can become separately darker or lighter than it is normally; in the former case, whatever its colour (except green) it can darken sufficiently to become brown, and even of so deep a brown as to have the appearance of blackness, leading in all the parts so darkened to melanism; in the latter case these same parts can become lighter, sufficiently to become tawny (*fauve*), yellow, and even of a yellow so pale as to appear white, leading, in like manner, to albinism.

The dark markings of the wing can spread or be displaced, or merge in neighbouring parts, or mask them more or less completely, or they can contract, become partly effaced, or even disappear, giving place to the light markings of the ground colour (*fond*). In other cases certain markings may become darker, and others lighter, or the general colour may become darker or lighter without altering the pattern. Opposite exciting causes, *e.g.* heat and cold, may produce the same result, this being caused, not by the special quality of the abnormal factor, but by the fact of the passing of the individual from a normal environment to that which does not suit it.

Among the exciting causes M. Pictet includes, but apparently with some doubt, electricity and mechanical vibration (*trepidation*)—the last, I believe, has been abandoned.

As regards the mechanism of variation, this has its principal seat in the scales, all of which, whether red, yellow, white, brown, or black, as well as the blue and violet ones, are striated on the surface so as to be capable of displaying the optical colours, and most of which are more or less filled with pigment in a granular form. The optical effect is related to the quantity of pigment in the scale, the intensity of the iridescence growing in inverse proportion to the pigment. In many cases the basal part of a scale is less filled with pigment than the distal part. Where the colours of the wing are light, the scales generally contain less pigment than where the colours are darker. There are, however, white pigment scales, as in the Pierids.

There are various ways in which melanism may be caused:—(1) The contained pigment may be greater in quantity; (2) it may be more strongly oxidised, which darkens it; (3) where there are both light and dark scales the latter may increase in number; (4) the scales may become so numerous as to overlap each other, and thus reinforce the darkness; (5) the scales may be enlarged, which increases the overlapping; (6) dark hairs may increase in number—like the scales, these are susceptible of change in their colouring matter; (7) one face of the wing may appear darker if, owing to the small quantity of pigment in its scales, the darker opposite face of the wing shows. Converse considerations apply to the causation of albinism; as regards (5), a very frequent cause, the scales may so diminish in size that instead of overlapping they scarcely touch, and leave empty spaces; they may diminish in size on both sides of the wing, which thus becomes transparent. (6) They may curl up at the sides, producing similar consequences to those numbered (4) and (5).

There is a very interesting chapter on cases where the optical and the pigmentary effects are combined. Green in the Pierids is not caused by green pigment, but by a mixture of yellow and black scales having *reflets bleus*; and in *V. io* the violet and green is caused by red and yellow scales mixed with white scales having *reflets bleus*.

The cause of variation may be generally stated thus. An individual which in the course of its ontogeny makes less pigment than its congeners, albinises; inversely, it melanises if it makes more pigment than is normal; the quantity of pigment

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[1] "Recherches Experimentales sur les Mécanismes du Mélanisme et l'Albinisme chez les Lepidoptères." By Dr. Arnold Pictet. Mémoires de la Societe de Physique et d'Histoire naturelle de Geneve, vol. xxxvii. Pp. 111–278+5 plates. (Geneve: George & Cie.; Paris: G. Fischbacher, 1912.)

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is much more important than chemical modification of it.

The author states that his researches confirm in some measure a fact which seems general among animals, viz. that melanism is a sign ot vigour and health; albinism, on the contrary, of the enfeebling of the organism. In melanism we have great abundance of pigment, increase in the size of scales and sometimes in their number, usually greater size, the females generally with voluminous abdomen, full of eggs; among Bombyces a great increase in pilosity. In albinism on the other hand, we have the opposite state of things; the scales also frequently deformed, curled, and atrophied, the wings often failing to develop, the abdomen slender, with few eggs or none; in the Bombyces little pilosity.

The author refers to Standfuss's hypothesis that this enfeebling may begin in the larva, and to his own experiments supporting this. Caterpillars ill-nourished, having been supplied with leaves they could ill bite into, produced imagines struck with albinism, supporting the view that albinism is a sort of anæmia of the organism. These modifications increase in succeeding generations subjected to similar conditions, but at the end of four generations the caterpillars adjust themselves to the leaves they found difficult, and then recover their vigour, size, and habitual colour. There are certain characters which exposure to abnormal conditions does not seem able to modify, such characters as are common to a group or genus, for instance, the discoidal spot of *L. quercus,* and the discoidal V. of *Ocneria dispar.*

Dr. Pictet's valuable researches certainly cannot be considered to exhaust the subject of the cause of variation in the colouring of lepidoptera. In the case of seasonally dimorphic species, for example, experiments seem to have shown that the difference in colouring is dependent more on the differential life habit of the spring and summer emergences than on mere exposure to environment or change of environment. With many lepidoptera long duration in the pupal stage, such as is produced by a low temperature, usually causes darkness, but in *A. levana* cooling the summer pupa for many months results in an imago so much brighter than the nearly black imago which comes from a pupal life in a summer temperature of five or six days that it looks quite a different species. F. MERRIFIELD.

THE SENSITIVENESS OF SELENIUM TO LIGHT OF DIFFERENT COLOURS.

SOME curious facts about the behaviour of the selenium cell are mentioned in a recent paper by A. H. Pfund.[1] The possibility of using these cells for ordinary photometric processes has often been discussed, but there are certain irregularities in their behaviour which set a limit to their usefulness.

One obvious difficulty lies in the fact that the rays of light to which the eye is most sensitive are not necessarily those which have the most effect on selenium. Pfund brings this out by reproducing—what has seldom been published before—a curve showing the distribution of sensitiveness of this material throughout the spectrum of a Nernst filament. The energy-maximum in this spectrum lies far out in the infra-red; the maximum luminosity to the eye (at moderate illuminations) is situated in the yellow-green. The maximum sensitiveness of selenium, however, is located in the red, and the shape of the curve is also distinctly different from the luminosity curve for the eye, so that inconsistent results would evidently be obtained if one tried to compare the light from various illuminants (having radically different energy-curves) by means of the selenium cell. But it may be mentioned that, according to a recent number of *The Illuminating Engineer,* such cells have a possible sphere for purely comparative measurements of one and the same illuminant; for example, they have been used for studying the fluctuations in daylight and the variation in illumination in the course of an eclipse.

Perhaps the most curious point brought out in these researches is the dependence of the maximum sensitiveness of the selenium cell on the intensity of the stimulus. With a very bright light the maximum is in the red, near 0·7 μ. But as the illumination is weakened, this maximum becomes less definite, and ultimately, in a feeble light, another maximum point, situated about 0·57 μ, appears. Ruhmer makes two kinds of selenium cells. The "hard" type is most sensitive to strong light, but relatively insensitive to feeble stimuli, and has its maximum in the red. The "soft" type, on the contrary, is most sensitive to weak light, and has its maximum in the green. This explains the discrepancies between earlier observers, some of whom found selenium to be most sensitive to yellow light, while others thought that red had most effect.

Now the interesting point to observe here is that this behaviour of the selenium cell is curiously similar to that of the eye. It is a well-authenticated fact, demonstrated many years ago by Sir Wm. Abney, that whereas at strong illuminations the maximum luminosity occurs near 0·58 μ in the yellow, in weak light it shifts to the green, probably near 0·51–0·53 μ. This is known as the Purkinje effect. In very feeble light the eye seems almost insensitive to red, while green and blues appear an uncanny light grey. Formerly this singular effect was ascribed to a struggle for predominance between the minute light-perceptive organs on the retina known as the "rod" and "cones." But, according to a later theory, this is not necessarily so, for the accentuation of the red end of the spectrum with increasing stimuli is characteristic of all photo-chemical processes.

At all events the similarity between the eye and the selenium cell in this respect is very suggestive. At first sight this complicated behaviour of selenium would seem unfavourable to

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[1] *Phys. Review,* xxxiv., No. 5, May, 1912.

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